Space Weather Technical Forecast

Issued on Tuesday, 01 February 2022 at 13:20 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1-G2 Minor to Moderate Storms during day 2 (2nd February) from a CME arrival. Chance M-flares (R1/R2 Radio Blackouts). Active electron fluence expected day 1 (01 February).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low with a number of C-class flares observed, the majority of these originated from AR2940 (Dsc/Beta) near the northeast limb), AR2939 (Esi/Beta) in the southeast quadrant. The largest was a C8 flare occurring at 01/0735UTC from AR2940. Currently the largest region, AR2936 (Eho/Beta) is stable and well-organised magnetically, and is not currently flaring. Two other sunspot regions are simple, stable alpha or small beta regions. No Earth-directed CMEs were observed in available imagery in the last 24 hours, although a few have launched off the west limb.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1 was averaging at 500km/s but has slowly declined to around 400-450km/s. Density has been mainly around or slightly below average. Total interplanetary magnetic field strength, Bt, was mostly weak around 5nT, with Bz between +5nT and -4nT, mainly staying in the positive orientation since yesterday evening. The Phi angle was mostly positive (away from the Sun). Geomagnetic activity was mainly Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at background levels. The high energy electron flux (greater than 2MeV), started at high levels (1e3pfu) yesterday afternoon (31st Jan), but reduced to moderate overnight and into this morning (1st Feb). The associated 24-hour electron fluence has been steady just below the Active threshold (1e8 integrated flux), with 7.9e7 recorded at 01/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be mainly low to moderate, with a chance of isolated M-class flares, most likely from AR2939 and AR2940 but AR2936 may also pose a threat if it becomes unstable. There is also a very slight chance (5%) of X-class flares from any of these three regions depending on how they develop over the coming days.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on 29 January is forecast to arrive at Earth overnight on 1st February into the 2nd February. Solar winds are expected to remain steady and quiet until then, with mainly Quiet geomagnetic conditions (Kp0-2), then potentially increasing to unsettled to Active (Kp3-4) with a chance of G1/G2 Minor/Moderate storm intervals (Kp5-6). The solar wind should then wane again during 3rd and 4th February, but perhaps increasing again later on the 4th due to coronal hole 49's high speed wind arriving (more likely over the weekend).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is

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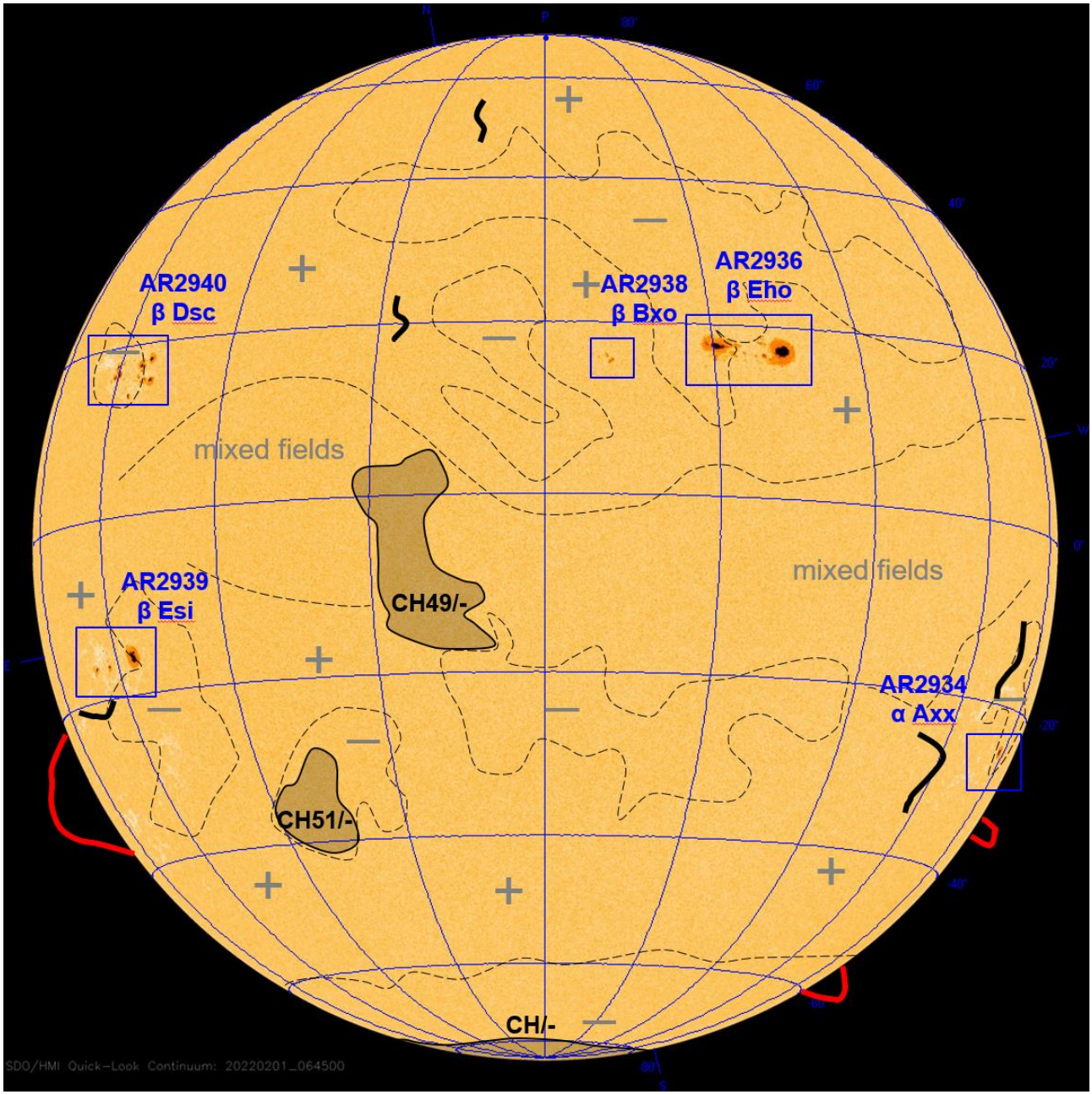
forecast to be at background levels but with a slight chance of rising close to or just above the S1 level, given any significant M-flaring, predominately from AR2936 though this remains quiet at this stage. The high energy electron flux (greater than 2MeV) may exceed the high (1e3 pfu) threshold again for a short time on the afternoon of 1st February, but remain mainly moderate. The CME arrival will pose some uncertainty of it's behaviour over the coming days, but most likely seeing further drops in counts during the 2nd February as geomagnetic activity starts. The electron fluence is expected to remain just below the Active (1e8 integrated pfu) threshold for the time being.

Figure 1. Solar Analysis Valid 01/0700UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

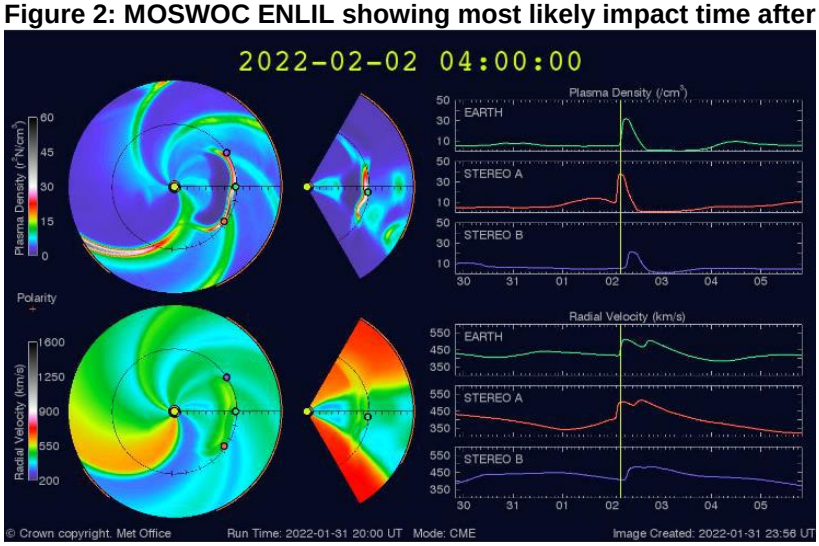
A full halo CME (which is more directed at Stereo A) on 29 January is expected to arrive at Earth overnight on 1st February into the 2nd. A chance of G1 or G2 storming is possible as it passes the Earth, particularly if the magnetic orientation is favourable for geomagnetic connection. The winds should ease during 3rd and 4th but fast solar winds from Coronal Hole 49 are likely to arrive at Earth for the coming weekend, possibly last thing on day 4 (Friday 4th February). This forecast is based on persistence and despite the hole being in a similar region of the Sun to the equivalent hole on the last rotation, there is some uncertainty in actual timing. Speeds of 600km/s are possible.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	70	20	15
Strong	G3	No	5	10	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
30/0633	Full (Asymmetric)	AR2936	08N 10E	540km/s	02/0400 +/- 9 hours	CME reassessed 31st to be slightly slower

Figure 2: MOSWOC ENLIL showing most likely impact time after midnight.



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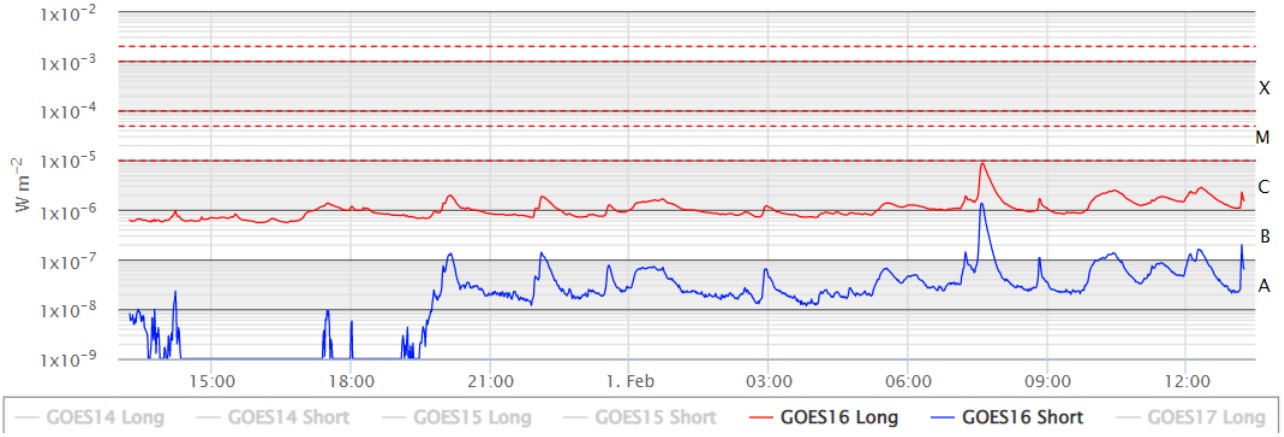
Radio Blackouts - X-Ray Flares:

Solar activity is low, with frequent low level C-class flares, mainly from AR2940 and AR2939. These two regions are so far only showing Beta-style magnetic arrangements, which keeps them stable and quiet, albeit AR2940 especially has a significant number of individual mature sunspot regions moving around in a compact fashion, which explains why this is the brightest region in the EUV spectrum. This region is the most likely to flare at M-class, whilst the others should remain at C-class.

AR2936 (Eho/Beta) in the northwest sector is the largest region but is the most stable and magnetically simple. However, because of it's size, a large-scale reconnection event cannot be ruled out, and this is the one that may pose a threat to proton storms due to it's current Carrington location.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: Latest GOES-16 X-ray Flux



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at background levels. Solar radiation storms are not likely in the period, however there is a slight chance (5%) for proton fluxes to rise given any significant flaring, predominately from AR2936 in the northwest quadrant if it becomes unstable and flares significantly (currently looking unlikely).

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) has been occasionally at high (1e3 pfu) levels recently with the recent high wind, but today it looks a little lower on average. The 24-hour fluence has topped out at 7.9e7pfu and is unlikely to rise any further during the next 2 days. The Geomagnetic activity from the incoming CME should tame these levels further, however the after-effects of the CME during days 3 and 4 may cause it to rise again with some uncertainty.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	30	20	30	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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